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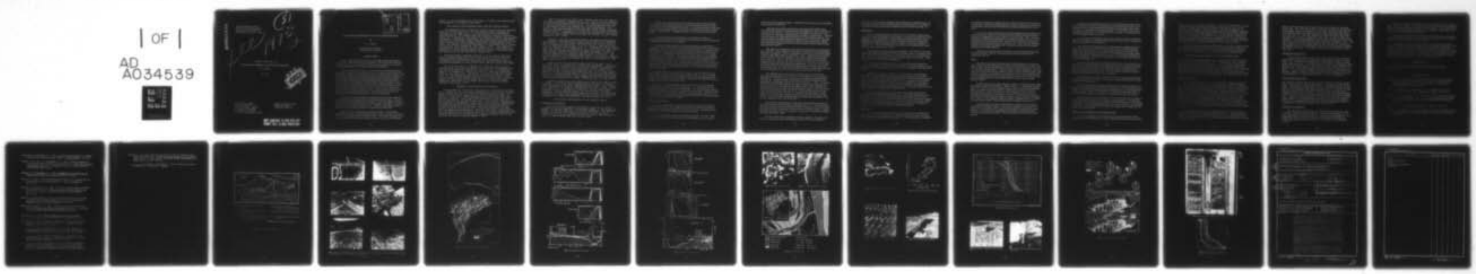

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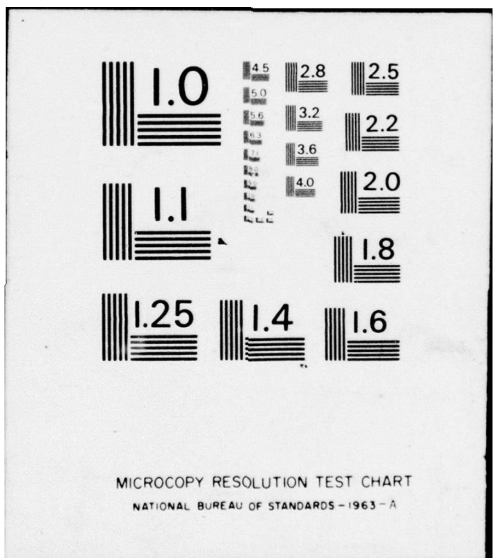
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# DEPOSITIONAL ENVIRONMENTS IN THE COLVILLE RIVER DELTA

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# DEPOSITIONAL ENVIRONMENTS IN THE COLVILLE RIVER DELTA

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## INTRODUCTION

Deltas, whether ancient or modern, are highly complex features and vary in size, shape, structure and composition. These variations reflect the relative importance of the numerous processes operating prior to, during and subsequent to deposition, the sine qua non of delta formation.

Deltas are being formed today, in a variety of environments including the extreme conditions found along arctic shores. Indeed, some of the world's largest deltas, especially that of the Lena River occur along arctic shores. Just as along many other coasts, deltas in the Arctic are forming at the mouths of small as well as large rivers and intermittent as well as perennial streams. In many respects--and especially from the standpoint of rivers--the Arctic is similar to mid- and low-latitude arid and semiarid regions (Walker, in press). It possesses rivers originating outside the region in which the delta is being formed as well as those originating within it. The Ob, Lena, Yenisei and Mackenzie Rivers can be considered as exotic rivers for the same reasons that the Nile, Indus and Colorado are exotic. In both cases they are perennial although they experience great seasonal variation in discharge.

In the Arctic, low temperatures during most of the year are responsible for preserving what little precipitation exists until the melt season. They are also responsible for the presence of permafrost. These two factors combine to reduce winter discharge drastically or even eliminate it completely. As summer arrives extreme flooding is likely to occur. Normally, high water is of short duration for most of the snow melts in a rather short period of time.

One such river is the Colville in northern Alaska. It drains about 60,000 $km^2$ or about 1/3 of the North Slope and is creating a delta at its mouth about halfway between Barrow and Barter Island. The delta's aerial portion has an area of 600 $km^2$ which makes it about one percent as large as the drainage

basin. It is the objective of this paper to discuss the depositional environments of the present-day delta.

## THE COLVILLE RIVER DRAINAGE BASIN AND THE COLVILLE DELTA

The sediments within a delta are mainly derived from the drainage basin of the creating river and thus depend on the lithology and structure of the basin (fig. 1) as well as prevailing hydrologic characteristics. The depositional and tectonic history of the North Slope left a variety of rock types and structures ranging from Paleozoic and Mesozoic limestones, sandstones, and shales and their metamorphic equivalents in the Brooks Range through Late Mesozoic sediments in the Arctic Foothills to the Quaternary and Recent unconsolidated silts, sands, and gravels of the Gubik Formation in the Coastal Plain (Brosge and Tailleur, 1970; Wahrhftig, 1965; Walker, 1973). The relative proportion of these source regions varies greatly. The Brooks Range occupies 26% of the drainage basin whereas the Arctic Foothills and the Coastal Plain cover 64% and 10% respectively.

The North Slope witnessed relatively little glacial activity during the Quaternary with no more than about 10% of the Colville Drainage Basin covered with ice at any one time (Walker, 1973). Nonetheless, the glacial and glaciofluvial deposits which resulted contribute sediments to the Colville River and its tributaries today.

The Colville Delta is composed of a subaerial portion which extends about 40 km from its apex to the ocean and a subaqueous portion which is advancing seaward into Harrison Bay. The subaerial portion is composed of a variety of features including distributary channels, bars and flats, sand dunes, ice-wedge polygons and lakes (fig. 2). The subaqueous portion has many features found in non-arctic deltas such as offshore bars and subaqueous levees. However, because of ice, which can be either an active or passive agent, additional forms such as ice scores and plunge holes are common (Reimnitz and Barnes, 1974).

## SEASONALITY AND DEPOSITIONAL PROCESSES

During some 75% of the year virtually all of the Colville Delta is in a frozen state. The major exceptions are the portions of water bodies deeper than about 2 m and the sediments beneath them. The upper 2 m of all water bodies and the active permafrost layer are frozen; in addition, a thin hard-packed snow cover lies over nearly the entire surface. This snow cover effectively limits wind as a deltaic modifier during the frozen state. When this is combined with the reduction or elimination of the river as an eroding, transporting, or depositing agent it can be seen that most deltaic processes are virtually nil for most of the year. The major exception to this general cessation of activity is the subice intrusion of sea water into the delta's distributaries. Such intruded water extends as much as 60 km upstream and through flocculation is probably responsible for increasing the rate of settlement of suspended sediment left in the river at the time of freezeup (Walker, 1974).

Spring (late May and early June), which lasts from the time of the first appearance of meltwater on top of the ice to the cessation of flooding following breakup, is the most important period of time in deltaic modification in the Arctic. It is the period when most of the season's water and sediment are carried oceanward. For example, the flood periods of 1962 and 1971, which lasted 25 and 19 days respectively, accounted for 48 and 58% of the annual discharge (Walker, 1973). Suspended load is even more extreme with as much as 75% of the annual amount being accounted for during the major floods (Arnborg et al., 1966).

Spring is also the time during which the highest flood stages are recorded. Floodwaters may extend over as much as two-thirds of the subaerial delta and cover tundra polygons and deltaic lakes as well as mudbars and sandflats. In 1971, 404 $km^2$ of sea ice at the front of the delta were flooded (fig. 3). Floodwaters, after progressing over the sea ice to distances of up to 10-12 km from shore join subice waters through pressure ridge cracks and separate, more or less circular, moulins or strudel (Reimnitz and Bruder, 1972), to continue seaward as a freshwater wedge (Walker, 1973, 1974). The rate of advance of this sediment-laden water is variable but averages about 5 cm/sec and has been mapped as much as 40 km seaward of the delta front (fig. 3).

Wind, relatively strong throughout most of the year, is an effective agent in several ways in the snow-free season. During the period of early snowmelt prior to flooding, sandbars and mudflats are exposed and often serve as source areas for the prevailing northeast winds. During actual flooding, wind is indirectly important for, if strong during high water, wave action on frozen banks results in extensive bank erosion. During the postflood period from late June through September, when sandbars and mudflats are exposed, wind is again effective in erosion, transportation, and deposition.

Marine processes are also mainly active during the short period of summer. It is then that wind-generated waves, ocean currents, tides and drift ice do their greatest amount of work. Ice, whether it be bottomfast or floating, dampens wave and tidal action. By the same token, if it is broken it is subject to drift and becomes an important force in the modification of the structure of bottom sediments. Currents during winter have been little investigated but indications are that they probably have little effect on the bottom sediments of nearshore environments (Barnes and Reimnitz, 1974).

## DEPOSITIONAL ENVIRONMENTS OF THE SUBAERIAL DELTA

### Distributary Channels

Most of the water reaching the head of the delta is carried seaward in two main channels. The eastern channel is the widest and deepest and carries about 75% of the total discharge. The western channel is the next most important with over 20% of the total. Branching from the east channel are several smaller distributaries (fig. 3) some of which only flow during flood.

The thalweg of both the east and west channels varies greatly in depth. In the western distributary the channel is shallow enough near both its mouth and head to freeze to the bottom during winter. The eastern channel is sufficiently deep to maintain unfrozen contact with the ocean throughout the winter (Ho and Walker, in preparation). Its deepest portion is some 12 m below normal stage level.

The sediments within these channels are also highly variable. In general, texture decreases in an oceanward direction along the distributaries and in a bankward direction from the thalweg.

Analyses of the bed materials of two sections only are presented here; Section I at the head of the delta and Section II in the upper reaches of the western channel (fig. 4, 5). Section I, 950 m wide at full bank stage, is asymmetric with the deepest part of the channel situated between 100 m and 160 m from the right bank (fig. 4). Bottom samples collected on 18 May through the 1.8 m ice cover represent non-flow conditions. The thalweg portion is mainly gravel although a few fine sediments are present. More than 70% of the bottom materials are over 10 mm in diameter. Some very fine sediment and even organic matter is also present indicating deposition since flow cessation during the previous fall (fig. 6). The proportion of sand increases toward the left bank such that at a distance of 400 m from the right bank the median diameter is 0.2 mm and no material coarser than 1 mm is present.

Samples taken during rising stage (12 June), lowering stage (18 June) and low stage (19 June) show the same basic pattern (fig. 4). Thus, the deep channel can be considered an erosional pavement which grades bankward into sands. The gravelly portion of the bottom is about 100 m wide which is about 1/10 the total high-water cross-sectional width.

Section II, the control section for the western channel, has a left bank which is being cut into the Gubik Formation (fig. 5, 7). The right bank is a pointbar with typical ridge and swale topography. The coarse grained material found at the bottom of this channel is from the Gubik Formation. Nonetheless, the bulk of the material is medium and fine sand ranging generally between 0.1 and 0.5 mm in size. Texture gradually decreases onto the pointbar where at the inner margin it averages 0.013 mm in diameter.

## Sandbars and Mudflats

Sandbars and mudflats are numerous, extensive, and highly varied in the Colville River Delta. They range in type from mid-channel bars to ocean-facing flats and in texture from gravelly-sand to silty-clay. Generally bar size increases and texture decreases in a downstream direction.

Virtually all stages of bar development can be found in the delta. They range from incipient bars covered during all but extremely low water to bars

which have become complex islands. Indeed many of this latter type are presently being eroded at a rapid rate.

Although small amounts of fine gravel are present at the head of many bars in the east channel and along the base of the right bank, only one bar can be considered truly gravelly. It is located just downstream from the river's first distributary in a relatively sheltered position (Nemeth, in preparation). Upstream from this island, bars with moderate amounts of gravel are fairly common. The Gubik Formation is probably the source region for most of the gravel. The only portions of the actual delta bordering on the Gubik are along the west channel. Bars immediately downstream from the cutbank portions of this contact also have small amounts of gravel.

Most delta bars developing in the Colville are controlled by unidirectional flow. However, a few situations prevail where a reversal of flow during flooding affects bar development. One bar so affected is Putu bar (fig. 8) which has been studied in some detail (McKenzie and Walker, 1974). Large amounts of sediment may be deposited on the bar especially at times of low flow accompanying flow reversal (fig. 9). This bar, like many in the delta, is backed by sand dunes. Interactions within the dune-bar-river complex result in several overlapping but relatively distinct units as evidenced by composition. These units vary in position grading from Putu Channel itself through a mudflat, bar and sand terrace into the dunes (fig. 10). Texture across this bar has an average range from 0.02 mm on the mudflat to 0.3 mm on the sand terrace at the base of the dunes.

The sediments which actually make up the bar have several origins. Most of the sediment comes from riverbanks in the adjacent part of the channel, although much of the fine sand, silt, and clay is brought in as suspended load from upriver. During the height of the flood period some 500,000 tons of suspended load is carried past Section I per day (Arnborg et al., 1967). In the case of Putu bar and other dune-backed bars, sand is contributed in large amounts during the time snow is melting from the adjacent dunes. Such meltwater runoff is greater than for the tundra surface because the irregular relief of the dune results in the formation of deep snow drifts. Many temporary fans form at the base of the dunes on bars and river ice. These are later eliminated or highly modified by river flooding. Organic matter including driftwood (mostly small willow), peat shreds, and other plant remains are important ingredients of Putu bar and virtually all other bars in the delta.

Bar structure, because of the variety of processes operative through the year and the nature of their sequence, is complex (fig. 10). A study of some 18 microrelief features on Putu bar showed that winter, although it prevails throughout most of the year, is generally a period of little morphologic change. Indeed, most alterations on the bar are the result of river activity during the short spring (McKenzie and Walker, 1974).

The front of the delta is composed of extensive mudflats. There are relatively flat, featureless forms which generally contain little foreign material.

However, peat shreds in the troughs of ripple marks are not uncommon (fig. 11) and a few large tree trunks--probably from the Mackenzie River--are present at the contact between the flat and the vegetated zone of the delta front (fig. 12).

## Sand Dunes

Eolian transported material is found over most of northern Alaska (Black, 1951) and is especially common in river valleys. Both active and stabilized dunes are present in the Colville Delta. Stabilized dunes are generally long, narrow vegetated ridges generally with a smooth, rounded surface and few blowouts. Those blowouts which are found in stabilized dunes are normally initiated by animal activity. Most of the stabilized dune systems are oriented parallel to and on the lee side of former river courses.

Active dunes are found in two distinct locations. One location is the inner edge of the extensive mudflats at the front of the delta where low, irregular dunes form. The other is on the western and southwestern sides of river channel bars where dunes, oriented normal to the prevailing NE winds, are numerous. These dunes fit Melton's (1940) foredune category.

Some of the dune ridges are as much as 4½ km long and are highly dissected. The windward face of a dune ridge is generally straight although in cases where the dunes are perched on other forms, such as peat banks, the base may be uneven.

Delta dunes are composed mainly of very fine and fine sand although in the troughs of the blowouts coarser material including fine gravel is present (fig. 13). The size of the dunes correlates closely with the size of the bar upwind from the dune. The active period of dune formation is during the non-flood portion of the snow-free season. Bars--from which snow melts first--are a good source region prior to flooding. Wind at this time transports what material is moved to the snow surface on and behind the dunes. The discoloration that occurs often emphasizes microrelief features (Walker, 1967).

During the flood period, bars have their supply replenished and are excellent source areas during summer and fall. If the season happens to be dry and windy much material is transported to the dunes and the tundra surface. Ephemeral barchans (fig. 14) are not uncommon and many of the flats are stripped of most of their sand supply (fig. 14). A common overbank type of eolian deposit is the wind stripe which is a long (up to 30 m), narrow (about 1 m wide) and moderately thick (several cm) deposit of relatively fine sand.

## Riverbanks

The riverbanks of a delta are usually distinct and often very informative. They display much of a delta's history in easily observed form and can be used to determine dominant materials and structures. In the Colville delta, riverbanks

are composed of materials ranging from silts, sands, and gravels to thick layers of dense peat. Most banks average between 1.8 and 4.5 m above mean water level although some banks cut into sand dunes and the Gubik Formation are 7 to 9 m high.

In 1971, data were collected from 170 banks along the main distributaries of the Colville Delta. Analyses of these data show that 59% of the delta's banks are erosional, 35% depositional and 6% neutral (Ritchie and Walker, 1974). Both the erosional and depositional categories have a number of types. Most (75%) of the erosional banks are composed of peat. Distinct horizons of thick, fibrous peat separated by thin layers of silt are common (fig. 15). Other erosional banks are composed of old sand dune deposits (3%), the Gubik Formation (7%), laminated lakebed silts and other materials.

Natural levee deposits within the delta are less well developed than along many river systems. However, during flooding levees frequently become conspicuous (fig. 2a).

## Lakes

One of the most conspicuous features of the Colville Delta is its system of lakes; conspicuous not only because of number but also because of variety in both size and form. Lakes in the delta include those which now occupy old river channels, terrace flank depressions, swales of ridge and swale topography, inter- and intra-dune depressions and low-centered polygons. Nearly all of the delta's lakes, the levels of which vary somewhat, are drained by flow over the lowest edge and by slow seepage through the active layer during the melt season. However, many lakes are connected to the various distributaries by narrow and often quite lengthy channels.

Several distinct factors affect deposition in lakes, including especially depth and whether flooded during breakup. Shallow lakes--i.e., those lakes less than about 2 m in depth--freeze to the bottom during winter, have permafrost beneath them, and usually have large amounts of vegetal growth in them. By far the greatest number of lakes in the delta are in this category as most of the low-centered polygons and intra-dune lakes are shallow. Bottom growth in most of these lakes is caused by the accumulation of organic matter mixed with windblown sand. However, those polygons subject to flooding, especially those in a natural levee-backswamp system, receive large amounts of sediment from the river.

Those deep lakes not subject to flooding have relatively small amounts of material added and that is organic. One source of material is the banks of the lakes which are subjected to wave and ice action aided by thawing of the frozen material. In the process of lake expansion ice wedges are melted leaving an inverted relief along the lake edge. These negative forms act as traps for lake deposits.

Change in the Colville Delta is rapid as is well illustrated by lake history. As mentioned above, many of the large lakes are connected with the river. Most connections occur when a meandering distributary cuts through a lake's bank. Although river meandering is the dominant agent, the lake itself usually aids an impending breakthrough. Such breakthroughs are common; a half-dozen lakes have been tapped in the past 20 years.

As the surface of most lakes is higher than normal river level, connection results in the exposure of the shallow shore around the lake which represents the most recent expansion of the lake itself.

Once connection is made the lake is influenced by all changes that occur in river level. Flow is into the lake on rising water, out of it on lowering stage. During breakup flooding (fig. 3) large quantities of water heavily laden with sands, silts, and clays flow into the lake. As the floodwaters enter they spread out and, because of a resultant decrease in velocity, the included sediments are sorted and deposited. The result is the formation of a lake delta with its head at the point of breakthrough.

Such lake deltas continue to develop with each flood. A core from one such lake shows that at least 25 major floods added sediment to the lake bottom in less than 10 years. Subsurface lake deltas continue to grow until eventually parts of them are exposed even at high water. These lake deltas are similar to those formed in larger systems where water flows into relatively tideless seas even to the point of the creation of a bird's foot arrangement.

These lake deltas increase in length and width and eventually divide lakes, often into unequal parts. In time, such lakes are normally filled and at low river stage become subaerial forms.

Although deposition is the dominant process for a long period of time, it is by no means the only process operating in the lake area. The river channel which caused the breakthrough in the first place usually continues to migrate lakeward and in the process erodes the lake deposits it originally brought to the lake. In the Colville Delta, lakes at every stage in the sequence described are present.

Another relatively unique lake type is the intra-dune lake (fig. 2f) which is a type of perched lake that forms in blowouts within sand dunes. The perching results because of the presence of a permafrost controlled aquaclude. These lakes are usually small and quite ephemeral. However, as they provide a moist situation within dunes, vegetation is quite abundant so that organic matter mixes with sand to form the bottom materials.

## Other Aspects of Deposition in the Subaerial Delta

As noted most deposition is concentrated in the short flood period which centers around river ice breakup. At first, floodwater flows under the ice in deep

channels and over ice which is bottom fast. The only ice movement is vertical. Deposition during this time occurs on top of bottom-fast ice in some river channels, in tapped lakes, and on the ocean. Once the ice begins to move, it also becomes a transporting agent carrying not only any formerly suspended material which may have been deposited on it but also material (both mineral and organic) that became incorporated in or on it during and subsequent to freezing. Such material is frequently as heterogenous in size as in type and is deposited where the iceblock becomes grounded. Thus, nonsorted materials are commonly found on the tundra surface as well as on river bars.

Although the suspended material deposited on river ice is usually carried downstream from the point of deposition, the same is generally not true for that sediment deposited on lake ice. In tapped lakes ice melts in place and the sediment is added to that which settled directly from the water itself.

## DEPOSITIONAL ENVIRONMENTS IN THE SUBAQUEOUS DELTA

The depositional environments of the subaqueous portion of the Colville Delta have received relatively little study. Near the shore, water is shallow limiting surface movement during summer and ice is bottomfast complicating examination of bottom sediments in winter. Some grab bucket samples and cores have been collected and analyzed (Barnes and Reimnitz, 1974; Furbringer and Walker, 1974) although much of the work to date has been devoted to studies of the interaction between fresh water and sea water during spring and summer (Walker, 1974) and nutrients (Alexander, 1974; Hamilton et al., 1974).

### The Bottomfast Ice Zone

Out to a depth of about 2 m sea ice is bottomfast during the winter and the first part of the flood period. The only exception is those few channels which lead seaward from the mouths of the major distributaries and even parts of them may be shallow enough to freeze to the bottom. As river flooding and breakup is initiated prior to sea ice breakup, floodwater from the river progresses over the sea ice and much sediment is deposited on the ice. It varies in thickness up to several cm. The outer edge of overflow (figs. 3, 16) varies from year to year but appears to lie between the 2 and 4 m contour. Sorting occurs with coarser sediments generally deposited on the ice near shore and finer sediments farther out (fig. 16). Some of this sediment is lost to the delta by the drift of sea ice away from shore. However, during most years most of it is added to the bottom through melting of the sediment-covered ice in situ.

Bottom sediment in the zone is subjected not only to river and wind induced wave action but also to disturbance by drift ice. Such disturbance is relatively minor, however, because during winter the ice is bottom fast and most of the ice has melted from the area before summer drifting occurs (Barnes and Reimnitz, 1974).

Some 15 cores have been taken from this zone, two of which are discussed briefly here. One (Core 331) is from a relatively sheltered bar off the mouth of the eastern branch from beneath 1.6 m of water; the other (Core 346) is from somewhat more open water area off the central part of the delta under 2.1 m of water (fig. 17). Core 331 consists of a series of layers of fine sands and silts many of which are separated by thin layers of peat and other plant fragments. The core has sediment ranging in grain size from 0.002 to 0.4 mm (fig. 18) and is about 50% very fine sand (Furbringer and Walker, 1973). The layers within this core have been relatively little disturbed as evidenced by the parallel layers. Core 346 tends on the whole to be finer material although some sands are present. Its structure, however, shows evidence ice action (fig. 17b).

## The Sea Ice Drainage Zone

The narrow zone near the outer edge of the overflow area where floodwater drains through pressure ridge cracks and moulins is unique to arctic deltas. It is a zone which is affected by a strong influx of water at distinct points along sharp lines. This water with the sediment it still contains creates potholes in the bottom which can be observed on sonar images (Reimnitz and Barnes, 1974). Just what sedimentary structures prevail in this zone is unknown. It is likely that the materials are heterogeneous and that particle size decreases rapidly out from the zone because of the rapid decrease in velocity of the floodwater as it spreads seaward from this sea-ice drainage zone.

## The Freshwater-Wedge Zone

The floodwater draining from the sea ice surface together with that flowing in sub-ice channels forms a fresh water wedge as it continues seaward (Walker, 1973c). The interface created between the two water types is sharp as indicated by both temperature and salinity profiles across it. However, an examination of suspended load in the zone of advancing water has shown that sediments settle across the interface. The total amount of suspended material in the ocean area of the delta during flooding was calculated for 1973 (Walker, 1974). Samples from the stations off the eastern front of the delta contained higher amounts of suspended material than those from either the central or western sectors supporting the observations that delta expansion eastward is continuing at a more rapid rate than to the north or west.

## Summary and Conclusions

The delta of the Colville River, presently forming on the Arctic coast of Alaska, is highly varied and complex. The extreme seasonality of processes operating in the Arctic affect river discharge and sedimentation. Most morphologic changes within the delta occur during the short spring and summer and especially during the period of high floods which accompany breakup.

Despite the relatively short period of activity during the year, morphologic change may be great. Riverbank erosion is often rapid and the numerous lakes are frequently tapped by meandering distributaries. These tapped lakes, portions of the general tundra surface, and the numerous sandbars and mudflats receive much sediment during flooding.

Because river flooding occurs before the breakup of sea ice, floodwater advances over the bottomfast ice prior to draining through the ice to continue seaward as a wedge of fresh but turbid water.

The presence of a sea ice cover during the time when most sediment is carried seaward results in the creation of three distinct depositional environments in the subaqueous delta. These are the bottomfast ice zone which receives much of its sediment secondarily from the sea ice as it melts, the sea ice drainage zone which is a narrow band seaward of the bottomfast ice zone, and the freshwater-wedge zone. These subaqueous environments, like other depositional environments in the Arctic, are relatively unique.

## ACKNOWLEDGMENTS

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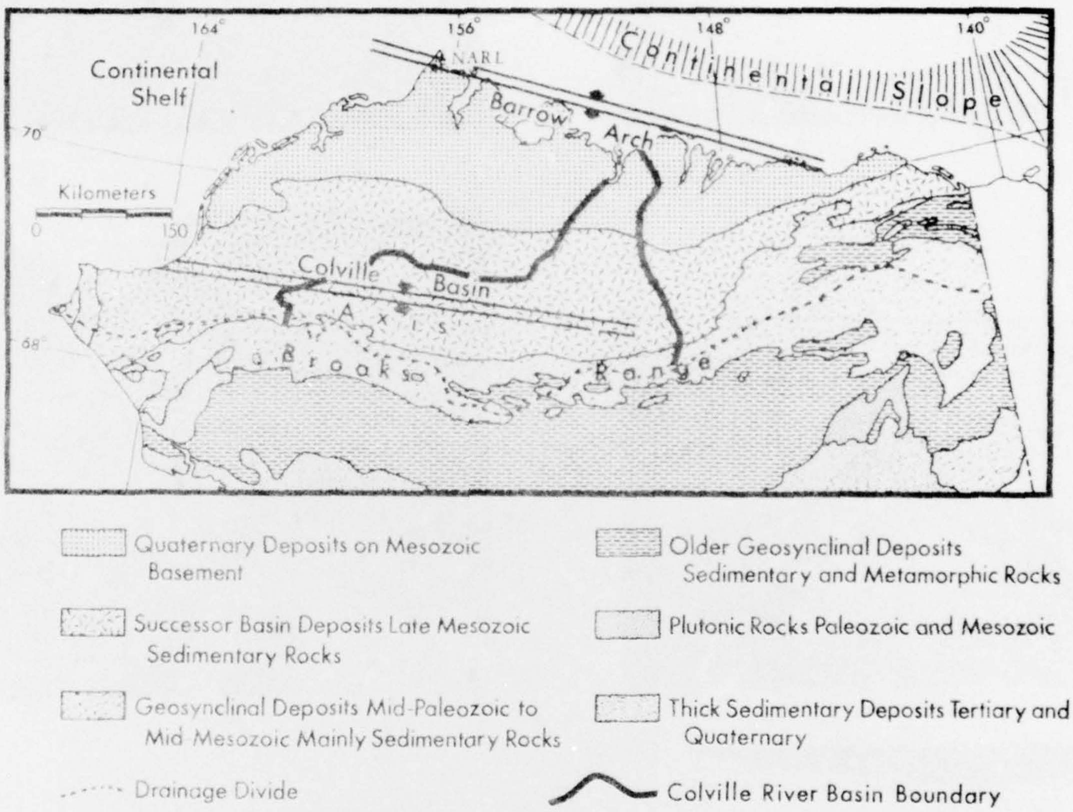


**Figure 1.** Colville River drainage basin.

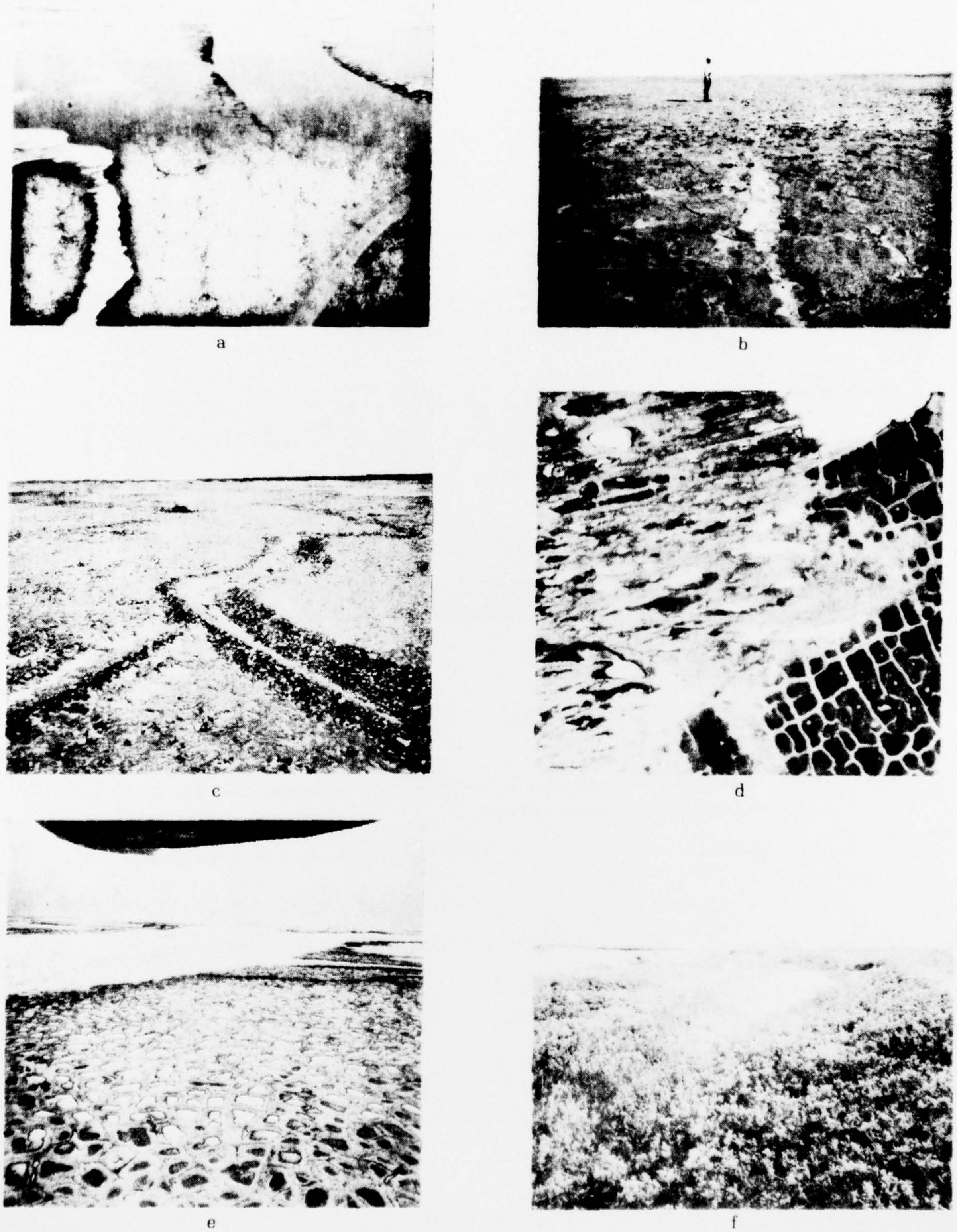

**Figure 2.** Features of the Colville River delta: a. distributary during flood, b. mudflat, c. ice scour on gravel bar, d. sand dunes and polygons, e. ice-wedge polygons, f. perched lake.

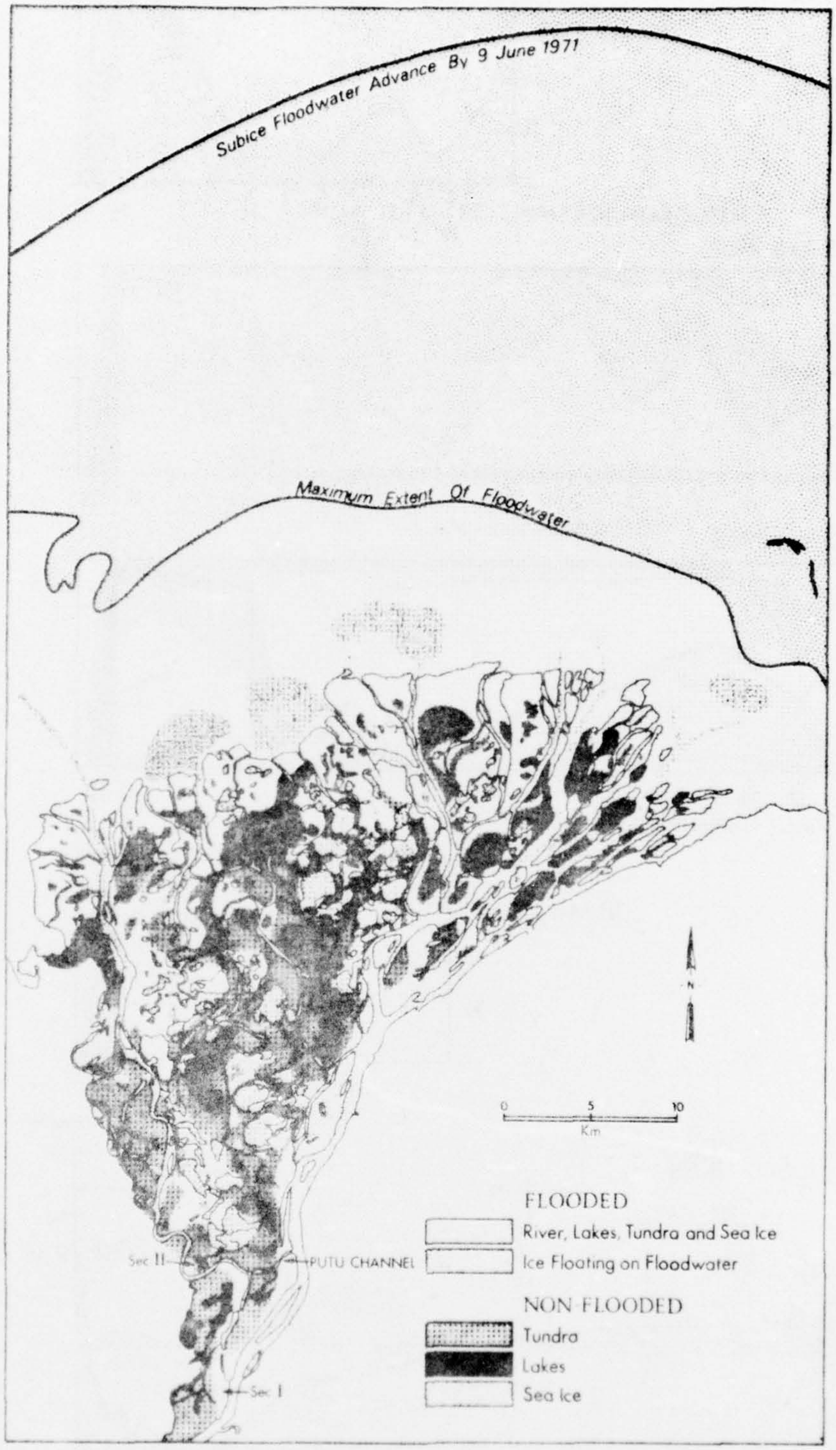


Figure 3. Colville River delta during spring flood, 1971.

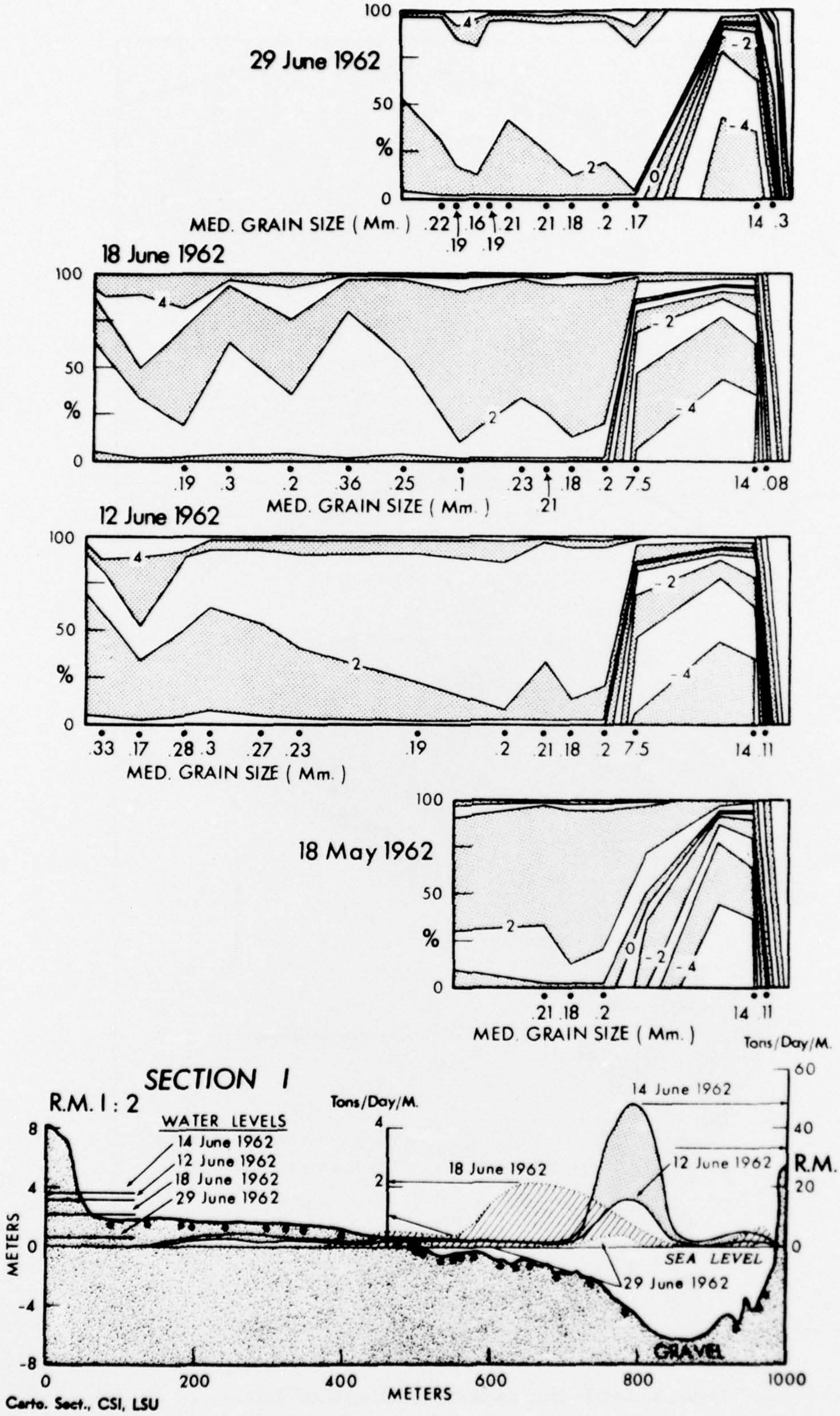


**Figure 4.** Bed materials, Section I, 1962.

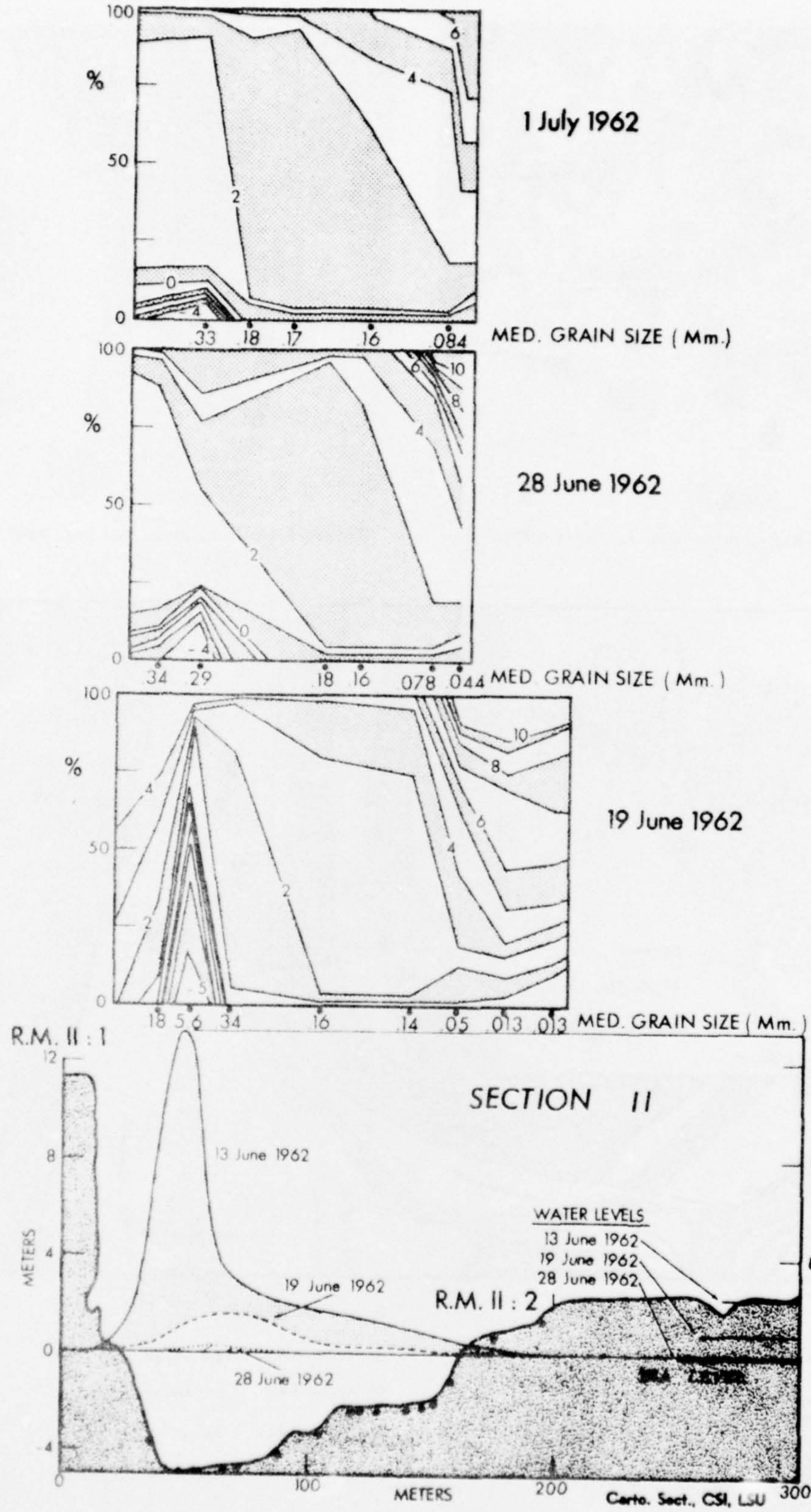


**Figure 5**. Bed materials, section II, 1962.

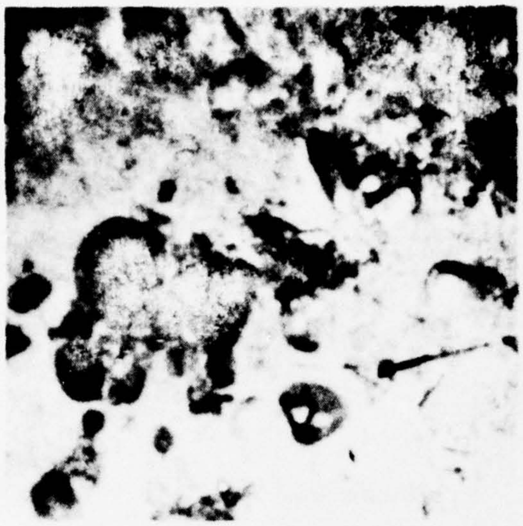

**Figure 6.** Bed materials. Section I, 1971.

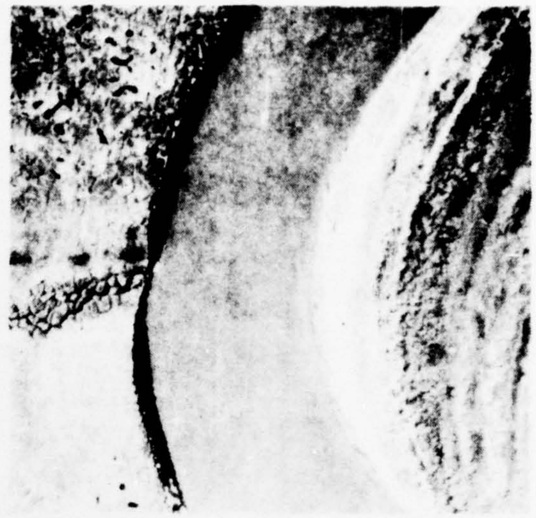

**Figure 7.** Cutbank and point bar, west branch.

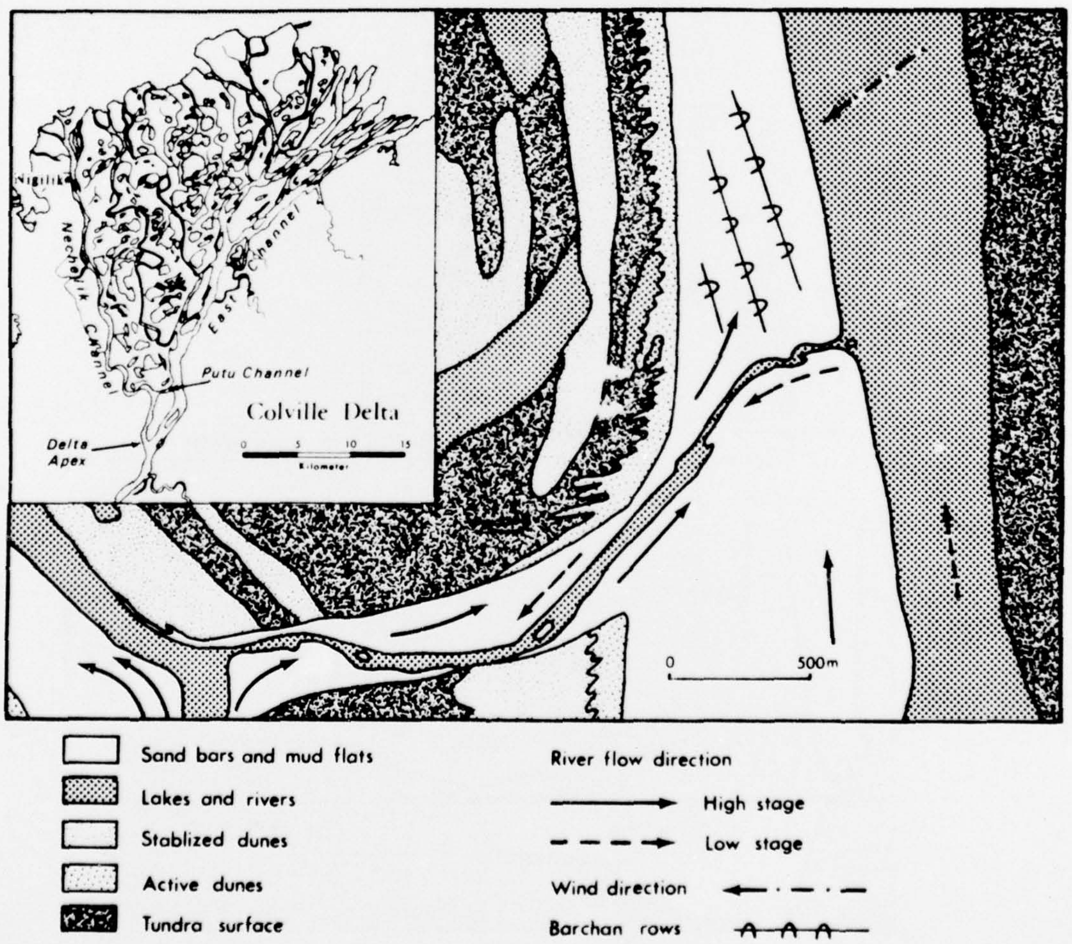


**Figure 8.** Map of Putu Channel.

Figure 9. Sediment deposited on snow in Putu Channel.

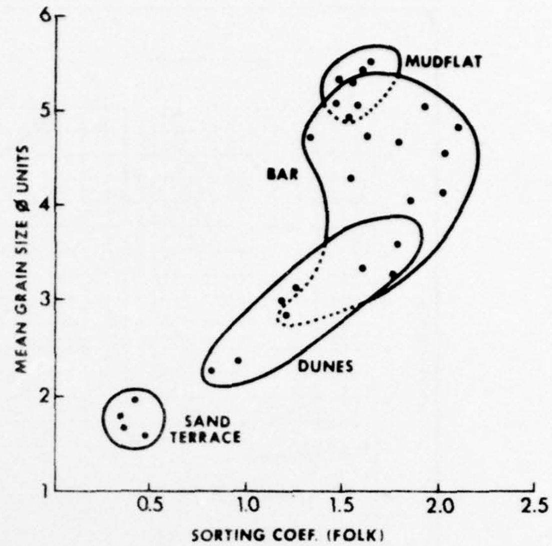


Figure 10. Sediment and Putu bar environments.

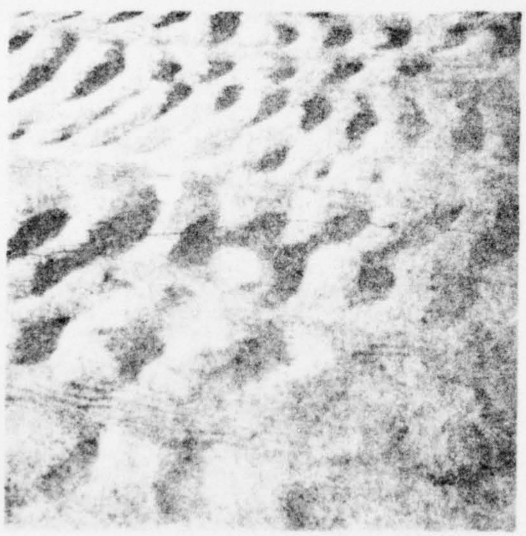

Figure 11. Peat shreds in ripple mark hollows.

Figure 12. Logs from the Mackenzie River.

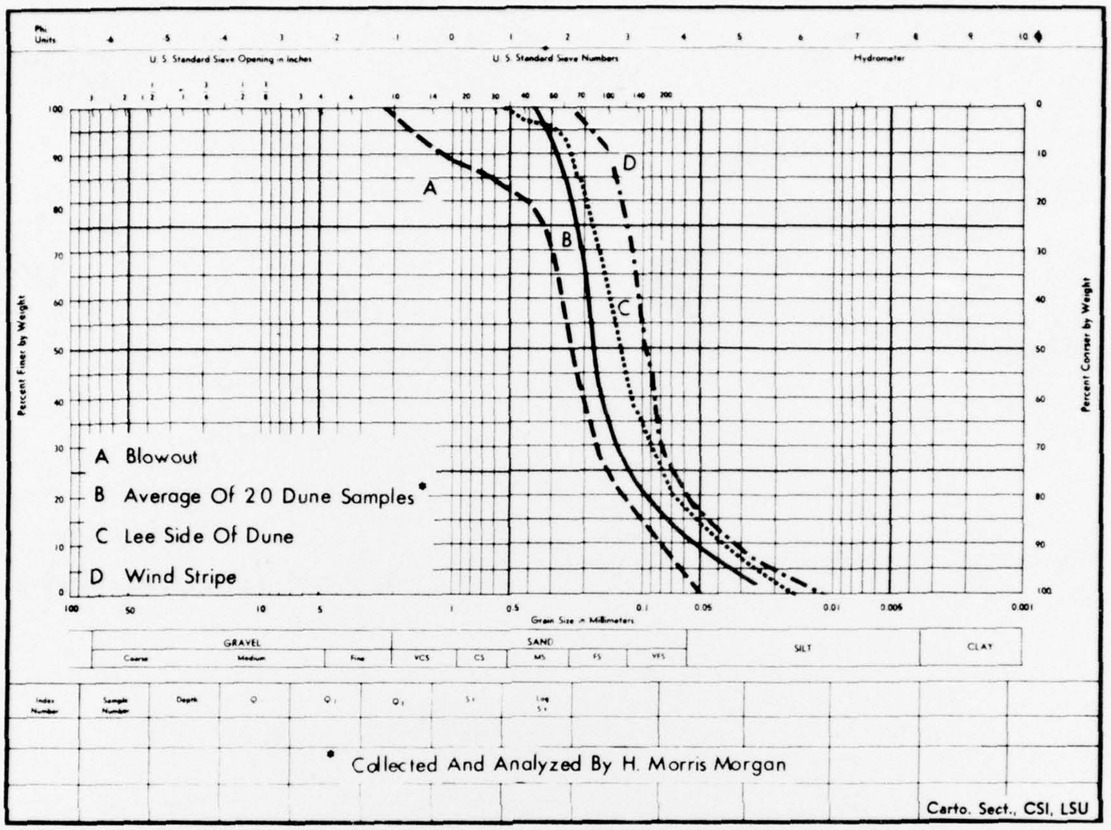


**Figure 13.** Texture of dune sands.

**Figure 14.** Barchan, Colville River delta sand bar, 1971.

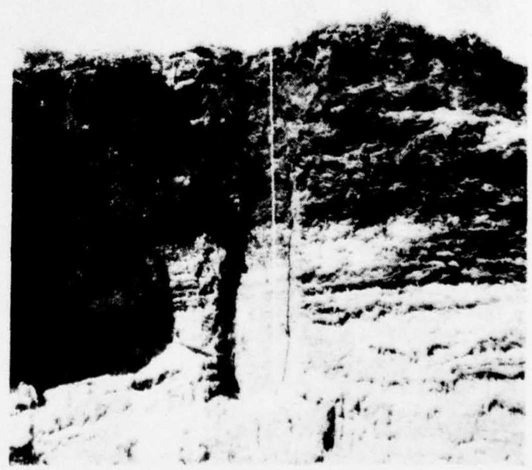

**Figure 15.** Riverbank showing gradation from sandy peats to peats.

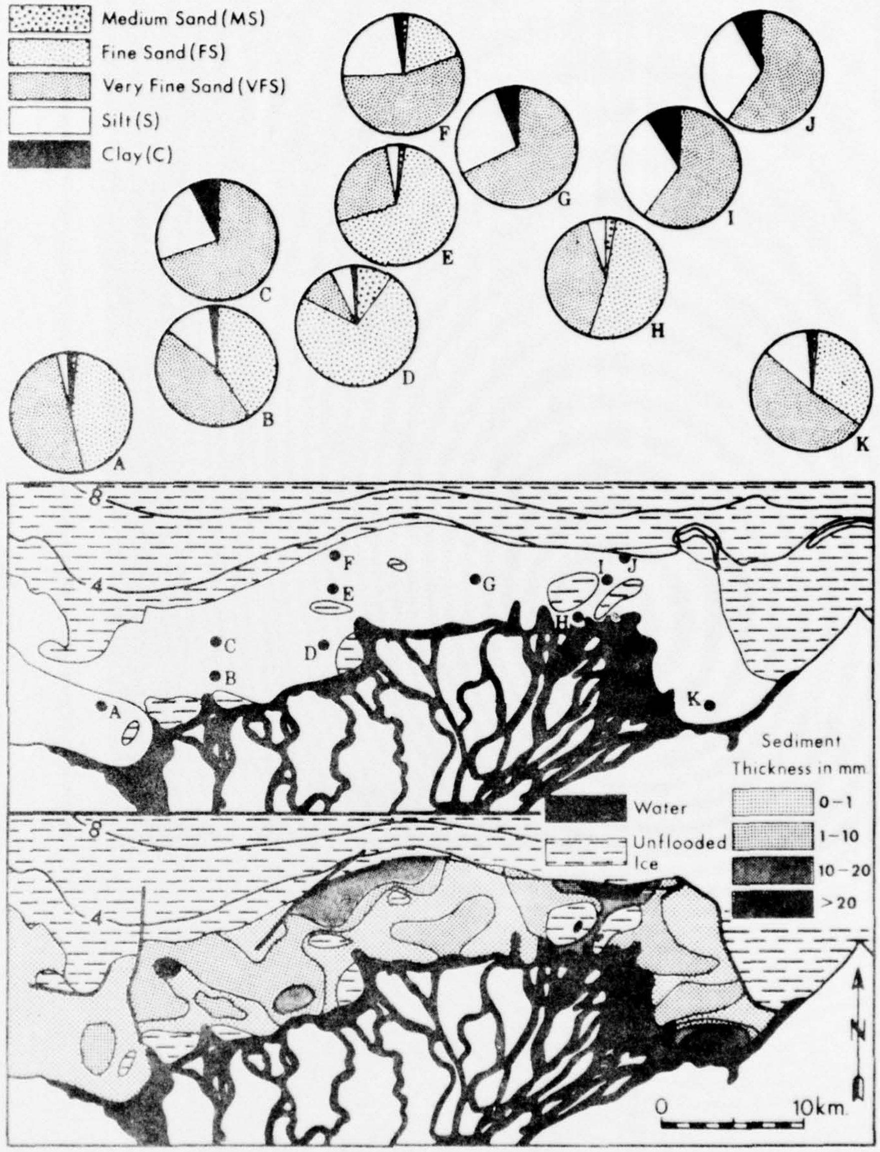


Figure 16. Deposition on sea ice during flooding.

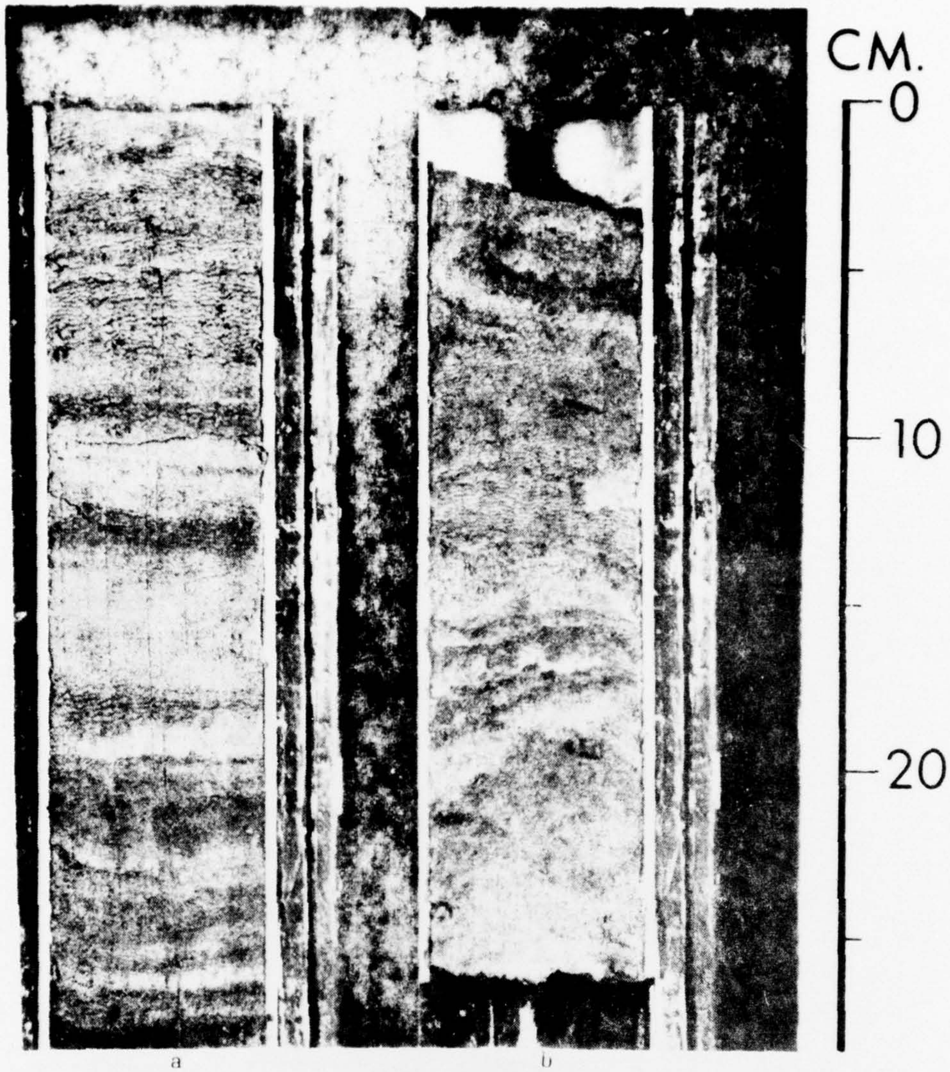


**Figure 17**. Cores from the subaqueous delta. a. Core 331. b. Core 346.

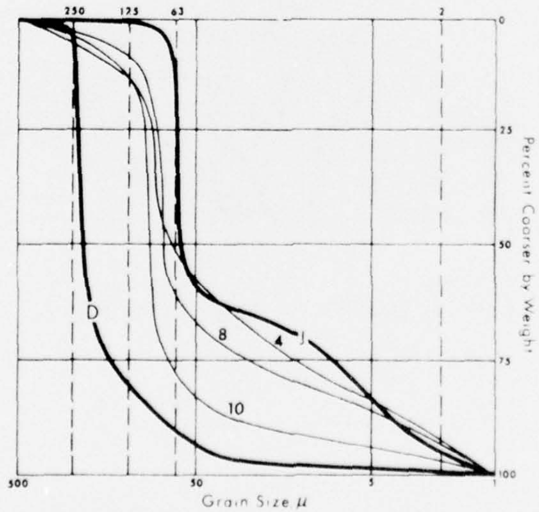


**Figure 18**. Texture of 3 layers of sediments from Core 331 and samples of 2 deposits on sea ice.

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13. ABSTRACT


The Colville River delta is growing northward into the Arctic Ocean at a point about 40 km west of Prudhoe Bay. Within the delta are a number of environments that owe their existence, characteristics and distribution to a variety of interrelated depositional and erosional processes. The subaerial portion (about 600 $km^2$ in area) of the delta contains a number of distributary channels, a variety of lakes and marshes, extensive sandbars and mudflats, and sandbar-bordering lee dunes. Subaqueous environments include channels, levees, distal bars and a complicated prodelta zone.

sq KM

Marine and fluvial processes are basically similar to those occurring in non-arctic deltas -- river flow, tidal action and wave energy are all present. However, both temporal and areal variability is great primarily because of the extreme seasonality of climate. The presence of permafrost and the long-lasting snow and ice cover (8-9 months) confine most activity to a very short period of time. The nature and timing of snowmelt and river and sea ice breakup affect depositional rates and locations. With most of the sediment being carried seaward during the period preceding sea ice breakup much deposition occurs on top of the ice. Nonetheless, floodwater carries some of its load over the sea ice and through a series of drainage holes where it joins subice flow and continues seaward. Erosional and depositional processes on the sea bottom are complicated along the zone straddling the seaward edge of overice flow.

Flooding of the subaerial portion of the delta is highly variable from year to year. Ice serves as a damming agent affecting floodlevels and deposition amounts. As a transporting agent, ice can carry variable size sediments and thus, areas subject to flooding have occasional erractics among their deposits. Because extensive bars are exposed during most of the non-snow covered period wind deflation and sand dune development are common.


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